Potential Initial Project for Suisun Marsh Levee Improvement
Submitted by Suisun Resource Conservation District
February 3, 2006

Name and Purpose of Potential Initial Project

This potential initial project, named the Suisun Marsh Levee Rehabilitation Project, is intended to improve the levee system integrity within the Suisun Marsh, and prevent uncontrolled flooding to public and private lands; protect state, county, and private infrastructure; protect the unique Bay-Delta ecosystem values and functions; protect the quality of state drinking water supplies; and to ensure state water deliveries for all beneficial uses.

Location

The Suisun Marsh is located in Solano County, California, roughly 40 miles northeast of San Francisco (see map, Attachment A). The nearest cities are Fairfield and Suisun. Interstate Highway 80 and State Route 12 form the northern boundary of the Suisun Marsh; Shiloh Road forms the eastern boundary; Interstate Highway 680 bounds it on the west side; and Grizzly and Suisun Bays form the southern boundary. The majority of the Suisun Marsh is situated at or below mean tide elevation and rises to a maximum of 10 feet in elevation. The Suisun Marsh has 52,000 acres of diked wetlands, 27,700 acres of upland grasses, 6,300 acres of tidal wetlands, and 30,000 acres of bays and sloughs. Its position between San Francisco Bay and the Sacramento-San Joaquin River Delta allows a mixing of fresh Delta water with salt water from the Bay, which results in a unique brackish marsh ecosystem. It totals 116,000 acres, is the largest contiguous brackish marsh in the United States, and represents approximately 10% of all remaining natural marshland in California.

Problems

The Suisun Marsh levee system is inadequate to protect the public and private resources of the Suisun Marsh and San Francisco Bay/Sacramento-San Joaquin River Delta. In the last 20 years, the Suisun Marsh has been hit by 4 major flood events (1986, 1995, 1998, and 2006). In each case, damage to land use, natural resource values, economic activities, and physical infrastructure has been extensive. Only 3.5 miles of Suisun Marsh exterior levees are eligible for levee maintenance assistance under the Delta Levees Maintenance and Subventions Program (see map, Attachment B). Additionally, only 20 miles of levees are eligible to participate in CA Department of Water Resources (DWR) Special Projects Program (AB-360) on the islands bordering northern Suisun Bay from Van Sickle Island westerly to Montezuma Slough (see map, Attachment B). Consequently, over 200 miles of exterior levees in the Suisun Marsh are publicly or privately maintained without financial assistance from existing levee maintenance programs are inadequately protecting the resources of the marsh and their failure presents the potential to negatively impact other resources in the San Francisco Bay/Sacramento-San Joaquin River Delta, including water quality.

The Suisun Marsh managed wetlands are a mosaic of public and private ownerships, protected by a fragile levee system. Most of these levees were constructed over 100 years ago with limited engineering and consideration for their structural foundations. A failure of a levee segment can jeopardize an entire island and can result in uncontrollable flooding of thousands of acres. Daily, these levees are subjected to wind erosion, storm events, wave action, rodent damage, subsidence, and other physical and environmental stressors.

In 1998, the CALFED Bay-Delta program established the Suisun Marsh Levee Investigation Team (SMLIT) to gather information on the costs and benefits of including Suisun Marsh levees in the CALFED program, especially as they relate to CALFED Water Quality, Water Supply Reliability, and Ecosystem Restoration Program (ERP) goals. SMLIT used computer models to evaluate hydrodynamics and salinity impacts of controlled and uncontrolled levee breaches in the Suisun Marsh.

Flooding in the Suisun Marsh during 1998 and subsequent breach analysis modeling studies have demonstrated that if certain Suisun Marsh levees fail, salinity can increase in the Sacramento/San Joaquin River Delta. In addition, salinity increases in the Suisun Marsh may result in exceeding the State Water Resources Control Board standards in Decision 1641. Modeling analysis indicates that ensuring the integrity of some exterior levees in the Suisun Marsh may be important to salinity and, therefore, water supply reliability in the Delta (DWR 2001). Over the years, the Suisun Marsh levee system has been maintained at the expense of private landowners, and public agencies that do not have the funds available to fully restore damaged levees. Maintenance and improvement of the Suisun Marsh levee system, including interior levees, is the responsibility of local Reclamation Districts (see map, Attachment C), private wetland managers, California Department of Fish and Game (which manages wildlife areas in Suisun Marsh), and Department of Water Resources (responsible for maintenance of several project facilities in the marsh).

Sudden failure of levees in the Marsh may flood areas that have subsided and may not be suitable for restoration into tidal wetlands and result in a loss of seasonal wetland habitat. Similar failures on Frank's Tract in the Delta (2005) demonstrated that long lasting environmental and water quality impacts can result from unplanned levee failures. The creation of large unplanned open water areas can result in uncertain changes in habitat for introduced or native species. In addition, a breach in exterior levees of the Suisun Marsh can lead to failure of internal levees that are not built to withstand hydrostatic forces or overtopping similar to an exterior levee. Further levee failure and subsequent habitat changes could undermine the CALFED Ecosystem Restoration Program's ability to achieve its goals, objectives, and targets. For example, failure of levees in the Marsh may flood areas that are not suitable for restoration into tidal wetlands and result in changes to salinity and/or tidal stage that may limit opportunities to effectively restore more suitable areas.

Although there has been no recorded human loss of life due to flooding, the threat to life and property persists due to the many permanent and temporary residents in the Suisun

Marsh. In addition, local, Statewide, and national resources depend upon maintenance of an effective levee system in Suisun Marsh. Besides protecting the State of California's water supplies, these exterior levees protect managed wetland values and functions, county and state lands, infrastructure (such as the Union Pacific Railroad), petroleum and natural gas transmission pipelines, electrical transmission lines, telephone lines, transportation corridors, DWR's and US Bureau of Reclamation's (USBR) water conveyance facilities, and residential dwellings.

Opportunities

The State of California's Suisun Marsh Preservation Act of 1977 required the preparation and implementation of a local protection program for the Suisun Marsh. In 1980, Suisun Resource Conservation District's Management Program to Preserve, Protect and Enhance the Plant and Wildlife Communities within the Primary Management Area of the Suisun Marsh was certified by the California Department of Fish and Game and the San Francisco Bay Conservation and Development Commission. This Management Program established levee specifications (Attachment D) that cover the design, construction and maintenance of exterior levees in the Primary Management Areas of the Suisun Marsh. The opportunity exists to evaluate the existing levees system integrity and make improvements to bring all exterior levees up to current specifications.

Additional improvements to certain Suisun Marsh levees can improve flood protection while increasing water supply dependability and ecosystem benefits. Levee improvement activities can include raising heights, repairing damaged sections, rebuilding levees, and/or extending landside slopes. Increasing heights protects against extreme tidal and flood events. Extending the landside slope further into managed wetlands improves levee stability and provides additional protection against seepage (Ramlit and Associates, 1983; DWR, 1995; Duncan and Wright, 2005). Other measures include bank protection with riprap and/or vegetation to reduce levee erosion. Although increasing the width and height of existing levees in certain areas to provide increased flood protection may result in impacts to critical habitat for State and federally threatened and endangered species, opportunities may exist to incorporate ecosystem components that result in net habitat improvements.

Suisun Marsh levees are essential for proper functioning of the State Water Project and Central Valley Project Facilities constructed in the Suisun Marsh under the Suisun Marsh Protection Plan prepared by DWR and USBR.. Building and maintaining dependable flood protection structures (levees) and minimizing the negative environmental impacts of levee maintenance and construction will be required in order to meet conflicting needs for protection of human and natural resources. Improving critical levees can provide continued protection of managed wetlands and existing habitats already protected by these levees, and specific levee improvements may provide additional incremental protection against regional salinity intrusion as the result of specific levee failures (*sensu* DWR, 1999, 2000, 2001).

Project Description

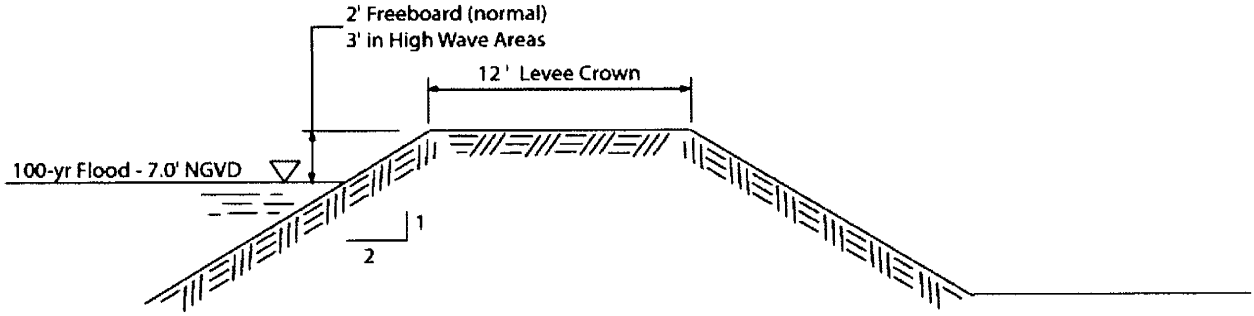
The basic features of this phased potential project are:

Phase 1. Conduct a baseline Suisun Marsh levee system centerline elevation profile and cross section survey. The initial estimated cost of completing this marsh wide levee survey on 229 miles of exterior levees is $250,000.

Phase 2. Rehabilitate levee damages resulting from the flooding during 2006. Interior levees not designed to exterior levee criteria now serve as exterior levees where previous exterior levees have failed. Other damaged exterior levees have failed eminently without repairs. While some Reclamation Districts may have submitted potential projects directly to the Corps, they should be considered in the context of this proposal to ensure a comprehensive plan to protect the resources of the region. Initial estimated costs are $8 million.

Phase 3. Implement routine levee improvement measures such as increasing crown height, placement of riprap, construction of splash berms or other protective measures, to prevent costly levee damage prior to full levee rehabilitation program implementation. Estimated cost $ 1.5 million per year.

Phase 4. Rehabilitate the approximately 229 miles of exterior levees in the Suisun Marsh. Rehabilitation is defined as using mineral soils to bring existing exterior levee profiles and width up to the minimum standards shown below:



Standard Suisun Marsh
Exterior Levee Section

Minimum berm width between the toe of the levee and the edge of any borrow ditch shall be 10'. Minimum allowance for settlement shall be 30%. Riprap should be replaced as permitted in the USACE RGP3. Rehabilitation costs are unavailable at this time and would be based upon engineering evaluations of the marsh wide levee survey and the determination of volume, sources, and scope of work required to meet existing standards.

The scope of individual projects with multiple partners would be less then seven million dollars and partners would be determined based on location and engineered designs.

In February 1983, RAMLIT Associates, Inc. prepared a report (Attachments E and F) for the San Francisco District of the U.S. Army Corps of Engineers, on the rehabilitation needs of the exterior levee system in the Suisun Marsh. This report reflected the levee conditions as of the fall of 1982 and determined the estimated total cost of rehabilitating the exterior levees to a uniform level of protection was estimated to be $52.7 million (September 1982 Price Levels).

The standard Suisun Marsh levee configuration (above) was designed just over 20 years ago. This standard is approximately 4 feet narrower at the levee crown than standards used for US Army Corps of Engineers for levees on federal flood control projects (known as "Project Levees") or standards recommended by Department of Water Resources for agricultural lands in the Delta. Although most of Suisun Marsh land surface elevations are below mean sea level, levees in the marsh range in height from 4 to 8 feet above ground level are much smaller than those in the Delta where land surfaces are now 10-25 below sea level.

The SRCD distributed the "Fact Sheet & Request for Proposals for Development of Potential Initial Projects" to all the Reclamation Districts in the Marsh. Some Reclamation Districts may have submitted potential initial projects directly to the Corps. Please consider these proposals in the context of this proposal. The Suisun Resource Conservation District operates as a facilitator with the private and public landowners of the Suisun Marsh and will gladly provide any additional assistance required to answer any questions.

Statement of Willingness and Ability to Cost Share

See Letter of Intent

Point of Contact and Agency Affiliation

Steven Chappell, Executive Director
Suisun Resource Conservation District
2544 Grizzly Island Road
Suisun, CA 94585
707-425-9302 (o)
schappell_srcd@direcway.com

Scoping and Screening Information

In your opinion, what is the urgency for your proposed project? Is there an imminent threat to life, property, critical habitat, or other prominent resource?

In order to continue protecting the local, State, and national resources in the Suisun Marsh and San Francisco Bay/Sacramento-San Joaquin River Delta, an immediate effort is needed as demonstrated by the flooding in January 2006.

Would there be a change in the magnitude, frequency, or duration of flood flows in other areas of the levee system as a result of the potential project?

No

What would the proposed project do to address flooding, ecosystem, water supply and quality, and other problems and needs locally and regionally?

See text of Initial Project Proposal

Are there non-structural or other ways to address flooding, ecosystem, water supply and quality, and other problems in the potential project area and if so what are they?

No

Who and/or what would benefit from the potential project?

See text of Initial Project Proposal

What is the likely Federal, State and local agency support?

Suisun Resource Conservation District (SRCD)
CA Department of Water Resources (DWR)
CA Department of Fish and Game (DFG)
US Bureau of Reclamation (USBR)
Bay Conservation and Development Commission (BCDC)
US Fish and Wildlife Service (USFWS)
NOAA Fisheries
California Bay-Delta Authority (CBDA)
Solano County Mosquito Abatement District (SCMAD)
US Army Corps of Engineers (USACE)

Are there any known challenges or obstacles that may delay rapid development and implementation of your potential project?

Maintenance of Suisun Marsh levees falls under the jurisdiction of several agencies at the federal, State, and local levels (DFG/SRCD 2004). Current regulatory restrictions on time of year work can be done (timing), the quantity of work that can be done (volume), and location of work constrain the amount of work that can be undertaken in any given season. In addition, the preparation of permit applications and long review and approval times can be significant obstacles for initiating and completing work. For example, current regulatory

requirements essentially eliminate the use of adjacent tidally deposited sediments for levee rehabilitation and repair. However, use of imported material, as a replacement requires concurrence from the Regional Water Quality Control Board prior to initiating any work. Regulatory constraints on maintenance and improvement activities for levees in the Marsh are known challenges and/or obstacles.

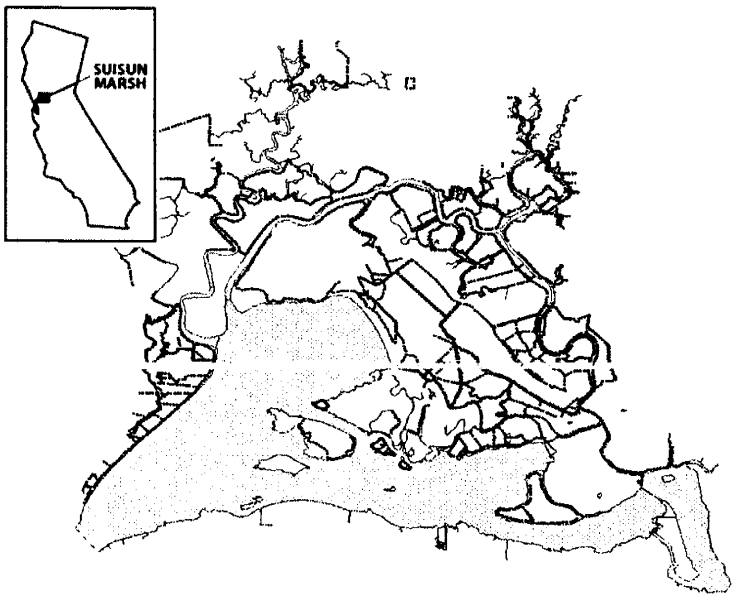
Is your agency ready, willing, and able to serve as a non-Federal sponsor for this potential project, and able to provide required cost-sharing and other assurances?

Yes. See enclosed letters of intent from the Suisun Resource Conservation District, California Department of Fish and Game and nine Reclamation Districts within the Suisun Marsh. Also enclosed are Proposals for Development of Potential Initial Project from the CanCan/Greenhead (#2139) and Honker Bay (#2130) Reclamation Districts.

SUISUN MARSH: LONG AND SHORT TERM ISSUES

BACKGROUND

California's Suisun Marsh (Figure 1) is the largest contiguous estuarine marsh remaining in the continental United States and, with a total of about 116,000 acres, contains more than ten percent of California's remaining wetlands (DWR 1999). The marsh itself consists of 52,000 acres of managed wetlands, 27,700 acres of upland grasses, 6,900 acres of tidal wetlands, and 30,000 acres of bays and sloughs.



Suisun Marsh is located just seaward of the confluence of the Sacramento and San Joaquin rivers, and the salinity of water entering Marsh channels is a function of tidal forces, the physical configuration of the marsh and surrounding channels and the amount of freshwater flow. The amount of freshwater flow is in turn affected by annual and seasonal variations in precipitation (both snow and rain in the Sierra Nevada, the Cascade Mountains, and the coast range) and in the amount of water stored and diverted by an extensive Central Valley water management infrastructure.

The Suisun Marsh is important to California and the nation for a variety of reasons. During the fall and winter, the marsh provides a temporary home for a significant portion of the migratory waterfowl wintering in California (Burns et al. 2003). In turn, more than one-half of the waterfowl using the Pacific Flyway may winter in California (Burns et al. 2003). The marsh provides essential habitat for 221 bird species, 45 mammal species, 16 species of reptiles and amphibians, and more than 40 species of fish. The marsh's complex biotic community includes such charismatic macro-fauna as Chinook salmon, river otters and Tule elk. The marsh is also home to numerous species of plants and animals that receive protection pursuant to the federal Endangered Species Act (ESA) or

the California Endangered Species Act (CESA). In addition to the ecological, waterfowl hunting, and other values of the marsh itself, Suisun Marsh is an integral component of the San Francisco Estuary system, including the Sacramento-San Joaquin Delta (Figure 1) - one of the most developed estuarine systems in the world (Nichols et al. 1986). The Sacramento-San Joaquin Delta (the Delta) is a key element of California's water supply structure. In an average year, federal and state water project pumps in the southern Delta divert more than five million acre-feet (maf) of water from the Delta for use on farms in the San Joaquin Valley and by urban and industrial users in the San Francisco Bay area, the Central Coast, and southern California. (In general terms two out three Californians receive part of their water supply from the Delta.) Water project diversions in the Delta and diversions and storage upstream reduce the amount of water entering the Bay and can influence the salinity (salt content) of water in the lower estuary, including Suisun Marsh. The salinity of water entering the marsh can affect the abundance and distribution of plants and animals in the marsh. Conversely, marsh activities (including construction and maintenance of levees surrounding managed wetlands) can affect water and salt movement in the estuary and the salt content of water in the Delta. Salt content is in an important consideration for urban and agricultural uses within the Delta and in downstream water service areas. The Suisun Marsh has been actively managed to some degree for the past 100 + years, with the recent focus on managing the marsh for waterfowl production and hunting. Since the 1970s much of the emphasis has been on ensuring that the marsh receives water of adequate quality to produce the plant communities thought necessary to support waterfowl production. Marsh management is a complex function of water levels and water quality and movement of water off and on private and public managed wetlands, tempered by regulatory constraints that affect the ability of managers of private and public lands to fill and drain their diked wetlands. The marsh is managed in the context of an extensive institutional structure and its management cannot be fully appreciated without a thorough understanding of who the players are and how they interact. Table 1 summarizes some of the key players and their responsibilities.

Table 1. Key agencies and groups having major responsibilities in managing Suisun Marsh.

Agency Name	Description of Responsibilities in Managing Suisun Marsh
Suisun Resource Conservation District (SRCD)	The SRCD has the primary local responsibility for monitoring and improving water management practices on privately owned lands within the primary management area of the Suisun Marsh.
California Department of Water Resources (DWR)	Although DWR has several functions relating to Suisun Marsh Management, its involvement in the marsh is mainly associated with mitigation of any adverse effects due to operation of the State Water Project.
California Department of Fish and Game (DFG)	DFG manages 12,000 acres of managed wetlands in the marsh for hunting, fishing and other recreational uses, administers CESA activities to protect special status species, and manages habitat intended to mitigate for SWP and other impacts.
US Bureau of Reclamation (USBR)	The USBR operates the Central Valley Project (CVP) which diverts water from the southern Delta through the Tracy Pumping Plant and works with DWR, DFG and SRCD to avoid, minimize or mitigate for its impacts in the marsh.
Bay Conservation and Development Commission (BCDC)	The BCDC is specifically charged with protecting the Suisun Marsh, the largest remaining wetland in California, by administering the Suisun Marsh Preservation Act in cooperation with local governments.
California State Water Resources Control Board (SWRCB)	Through its water quality and water rights authorities the SWRCB promulgates water quality standards for the Suisun Marsh and conditions DWR and USBR water rights permits to meet those standards.
US Fish and Wildlife Service (USFWS)	As part of its ESA authority, the USFWS issues biological opinions on operation of the State and federal water projects, including those facilities in the marsh (e.g. the MSSCG) and may require other federal permits be conditioned to protect listed species.
NOAA Fisheries	NOAA Fisheries has federal ESA responsibility for anadromous fish including winter and spring Chinook salmon and steelhead and has conditioned operation of the MSSCG and water diversions in the marsh to protect these species.
CALFED Bay-Delta Authority (CALFED)	The 2000 CALFED Record of Decision (ROD) calls for creation of an additional 5,000 to 7,000 acres of tidal wetlands in Suisun Marsh. Through its Ecosystem Restoration Program, CALFED funds marsh restoration projects.
Charter Group	The Suisun Marsh Charter, and its multi-agency member group was established in 2000 to develop a regional plan that balances implementation of the CALFED program with other preservation, management, and restoration programs in the marsh.
Solano Mosquito Abatement District	To limit mosquito production in wetlands the Solano Mosquito Abatement District may restrict the time when ponds can be flooded up in the fall.
The US Army Corps of Engineers (USACE)	The USACE issues permits to DWR, DFG and SRCD for work in the marsh, including facilities (404 permits) and maintenance (Regional General Permits). These permits contain conditions designed to protect water quality and sensitive species.

Today's Suisun Marsh consists of 158 parcels of private land managed for waterfowl production, plus another 15,000 acres of public land that are managed for waterfowl and for protection of listed and sensitive plant and animal species. Most of the land managed for waterfowl production is now behind levees that limit tidal exchange between the land and the channels. Oxidation and other factors have lowered the land surface behind the levees (subsidence) and the relatively soft material underlying the earth levees makes levee maintenance difficult and expensive. As was dramatically shown in February 1998 and January 2006, a combination of high tides, winds and barometric pressure differentials can result in the levees being overtopped and/or breached. It must be emphasized that, although at present Suisun Marsh is very different from the historic marsh, it continues to provide ecological benefits for a wide variety of plants and animals.

Over the past three decades, the original conceptual model, as adopted in regulatory hearings by the SWRCB, has driven environmental protection efforts in the marsh. DWR and the USBR have spent over $100 million to develop plans of protection, provide and maintain physical facilities (for example, diversion structures, the Suisun Marsh Salinity Control Gates), monitor salinity, fishes and other system components, and purchase and/or maintain land to mitigate for direct impacts of project operation and facilities on listed and sensitive species. Suisun Marsh landowners have also expended considerable sums to achieve the protection goals. Since the mid 1990's there has been movement towards a revised conceptual model of Suisun Marsh and how it interacts with the estuary. The 1995 Delta "Accord" and creation of the CALFED Bay-Delta Program provided part of the impetus to move from single species to ecosystem management. Some attributes of this developing model include the following:

- The marsh is an integral part of the estuary and what happens in the marsh affects the rest of the estuary.
- Ecological goals have been expanded from simply producing waterfowl to protecting the ecosystem and the many listed and sensitive species that are part of that system.
- Increased consideration is being given to levee stability and chances of flooding due to a combination of rising sea level, changes in precipitation patterns (and flows), and subsidence of land behind the levees.
- Increasing interest in creating new tidal marshes in the San Francisco Estuary and in Suisun Marsh.

Levees serve the primary function of flood control for Suisun Marsh infrastructure and natural resources. The majority of the Suisun Marsh, including wildlife habitat, is situated at or below mean tide elevation. Exterior levees were constructed to protect managed wetlands, county and state lands, infrastructure, and residences from uncontrolled tidal inundation and flooding. In many instances levees serve multiple purposes within the Marsh as important components of a highly modified estuary. Levee configurations can vary considerably in material composition, cross-sectional geometry or shape, strength, stability or integrity.

Historical construction of levees in Suisun Marsh have resulted in the isolation of wetland habitat from tidal action as fill material was placed on existing wetlands (USFWS, 2004). The building and maintenance of levees over time created a barrier between managed wetlands and adjacent waterways resulting in 6,300 acres of unmanaged tidal wetland out of the original 74,000 acres (Arnold 1996). Over time use of dredge material from adjacent channels for levees has resulted in deepening and widening of these channels resulting in some development of habitats for both native and introduced species. Levees can provide an interface both above and below the water surface creating habitat(s) for multiple estuarine species.

While the primary function of the Suisun Marsh levee system is to provide flood protection, over time habitat has developed along the levee waterside and landside slopes for native and introduced species. Fluctuating water levels on both the waterside and landside slopes creates opportunities and challenges for habitat management, preservation, and restoration. The building of levees has changed the marsh landscape and over time levees have become an integral component of this highly modified estuary. The current levee configuration is essential for the proper functioning of the DWR and USBR facilities constructed in the marsh as part of the Suisun Marsh Protection Plan and to meet water quality requirements under the State Water Resources Control Board Decision 1641.

LONG AND SHORT TERM ISSUES:

The Suisun Marsh levee system, a major component of the current Marsh configuration, protects certain habitats and serves as habitat for some species. These levees provide flood protection for managed wetlands, county and state lands, infrastructure, residences, and habitat. They are on the front line in protecting water quality and various estuarine habitats from salinity intrusion. In

addition to approximately 230 miles of exterior levees, many miles of interior levees were built to protect managed wetlands from flooding neighboring lands and to allow landowners to manage water quality and maintain their property for waterfowl habitat.

Levee breaches in Suisun Marsh due to winter flooding may be the most recognizable type of flood event (such as that experienced during 1998 and 2006). However, unexpected flooding and breaches at other times of the year (similar to the Jones Tract levee failure in the Delta in June 2004) occur in the Marsh as well. The August 1999 breach at the Sunrise Club on Chadbourne Slough (280 acres) is an example of a small breach (180 feet in width) that had impacts on salinity within the Marsh. Larger, region-wide breaches and flooding in the Marsh can have water quality effects in the Delta which can impact State Water Project and Central Valley Project operations (DWR 2001).

Suisun Marsh levees are under the constant pressure of the fluctuating water levels on the waterside slope resulting in changes in soil structure and stability which can result in failure. Water levels in the marsh can vary by about 6 feet during each daily tidal cycle. These water levels vary seasonally and in conjunction with events such as storms and lunar cycles. Sustained high water conditions, as experienced during 1998 and 2006, can occur due to high runoff from upstream storm events. The constant hydrostatic pressure on the levee slope creates opportunities for failure.

Maintaining certain Suisun Marsh levees is necessary for continued flood protection of managed wetlands, county and state lands, infrastructure, residences, habitat, and water quality. Maintenance activities are restricted in quantity and timing under the Regional General Permit from the USACE to avoid impacts to sensitive species.

Maintenance of Suisun Marsh levees falls under the jurisdiction of several agencies at the federal, State, and local levels (DFG/SRCD 2004). Current regulatory restrictions on time of year work can be done (timing), the quantity of work that can be done (volume), and location of work constrain the amount of work that can be undertaken in any given season. In addition, the preparation of permit applications and long review and approval times can be significant obstacles for initiating and completing work. For example, current regulatory requirements essentially eliminate the use of adjacent tidally-deposited sediments for levee rehabilitation and repair. However, use of imported material as a replacement requires concurrence from the Regional Water Quality Control Board prior

to initiating any work. Regulatory constraints on maintenance and improvement activities for levees in the Marsh may increase the potential risk for failure. This illustrates the direct conflict that exists between levees as habitat and levees as structures that provide flood protection.

Delays in approval of levee maintenance and repair applications, allows further damage to develop, resulting in increased repair costs. Restrictions on the use of rip-rap (for levee maintenance) and the use of herbicides (to control vegetation) can result in ongoing maintenance activities that may be more intrusive to species of concern. Once work is approved restrictions on timing, volume, and location result in work being scheduled for completion over several seasons, increasing overall costs and impacts to sensitive species.

Historically, dredging was typically done with either a clamshell or dragline dredge and provided a relatively inexpensive way of obtaining and placing fill material for levee maintenance and rehabilitation. The sloughs and channels adjacent to levees are subject to State and federal regulation since they provide habitat for special-status plants and animals. Restricting dredging activities results in use of landward sources of borrow material such as pond bottoms or material from distribution ditches. This material is typically high in organic content and less suitable for levee maintenance than Bay mud. Although this approach is more convenient and less expensive than importing material, it may result in reduced levee stability and contribute to subsidence and may not be feasible in the long-term. Engineering principals and practical experience show using mineral soils found in dredge material as opposed to organic materials provide increased levee stability. The lack of suitable material in the marsh for levee repairs results in increased costs, deferred maintenance, foregone improvements, and continuing impacts to species.

Improvements to certain Suisun Marsh levees can increase flood protection. Levee Improvement activities can include raising heights, repairing damaged sections, rebuilding levees, and/or extending landside slopes. Increasing heights protects against extreme tidal and flood events. Extending the landside slope further into managed wetlands improves levee stability and provides additional protection against seepage. Other measures include bank protection with riprap and/or vegetation to reduce levee erosion.

Suisun Marsh levees provide a physical barrier between public waterways and managed wetlands. These levees can limit access to privately managed wetlands, and public lands by preventing boat traffic from entering lands directly from the adjacent channels. Restricting access can be beneficial to preservation goals or enhancement of habitats in Suisun Marsh.

Since tidal wetlands in Suisun Marsh were diked and reclaimed for agriculture and waterfowl management, many Marsh properties have flooded at least once. Over time levees have exhibited deterioration or outright failure due to hydrostatic pressure, soil consolidation or settlement, overtopping, seepage/piping, and erosion. Other areas of increasing concern include: seismic vulnerability, land management (subsidence), and regulatory requirements.

The Marsh is underlain by thick layers of unconsolidated organic peat and bay muds, which have limited capacity to bear the weight of existing or enlarged levees (DWR 2001). These weak foundations exhibit significant consolidation over time as the weight of added levee material is not effectively supported by the existing underlying marsh peat soils. This problem is particularly significant in the southeastern part of the Marsh where settling of levees may equal the height of the placed fill within months of placement. Levee rehabilitation plans should account for the unconsolidated nature of the foundation and its effect on maintenance and rehabilitation.

High water stages in the Marsh can occur due to floods, unusually high tides, or atmospheric conditions involving high wind and low pressure. Not all levee sections in the Marsh are sufficiently high to protect against overtopping during extreme tide or flood events. Some levee sections may erode or wash away from the scouring action of water flowing across the levee crown and down the landside slope.

Movement of water through a levee caused by hydrostatic pressure against the water side slope can result from construction using permeable material, poor maintenance, rodent holes, and cracks. Seepage through the levee may lead to water carrying away material (piping) and result in larger seepage paths which can lead to levee failure.

Waves and tidal currents are the primary erosive forces on exterior levees. Unprotected exterior levee slopes may be undercut, scoured, or washed away. Erosive forces due to waves caused by

wind fetch are particularly evident along the many miles of levees facing Honker and Grizzly Bays. Waves due to boat traffic along levees of sloughs or channels in the Marsh also result in erosion of exterior levee slopes. Currents due to tidal or high runoff events can result in erosion of levee slopes, particularly during peak events.

There is also growing concern that seismic vulnerability in the Delta and Suisun Marsh has been underestimated. Unconsolidated marsh soils have limited capacity to bear the weight of levees and are vulnerable to seismic loading. The saturated soils in marsh wetlands may lose strength when subjected to ground shaking during an earthquake and result in levee foundation or slope failure(s). The frequency, intensity, and distribution of earthquake activity in Suisun Marsh along with the size, design, and vulnerability of existing levees are under review.

Observable subsidence in the Marsh is a concern since lower ground surface elevations reduce levee stability and increases the risk of levee failures. Continuing subsidence is documented to a limited degree through benchmark elevation change observations. Private, state, and federal facilities and operations critical to maintaining ecosystem health, water quality, beneficial uses, and public safety are at increased risk as subsidence continues. In 1991, the USGS and the California Department of Water Resources began a study of the effect of different water management practices on carbon inputs and outputs and subsidence on Twitchell Island in the western Delta. The results of the study indicate that permanent flooding of peat soils can stop subsidence and increase the land-surface elevation.

Management practices within Suisun Marsh managed wetlands can create conditions which contribute to the oxidation of bulk soil organic matter. Loss of this organic matter may lead to local and regional ground subsidence. The continuing subsidence of managed wetlands could affect levee stability and increase the risk of failure. Levee improvements to counter this increased risk can cause conflict with existing habitat and species.

The fluctuating water levels and hydrostatic pressure on levees can result in levee failure and loss of property and natural resources in Suisun Marsh. As demonstrated by the 1998 flooding and breach analysis computer modeling, salinity in the Marsh and Delta can be impacted and could substantially

affect California's water distribution system. Maintenance of levees to withstand the forces of fluctuating water levels can impact existing habitat and species.

THE SUISUN RESOURCE CONSERVATION DISTRICT'S MANAGEMENT PROGRAM TO PRESERVE, PROTECT AND ENHANCE THE PLANT AND WILDLIFE COMMUNITIES WITHIN THE PRIMARY MANAGEMENT AREA OF THE SUISUN MARSH

The cooperation and assistance of the staffs of the following agencies is gratefully acknowledged:

California Department of Fish and Game

California Department of Water Resources

San Francisco Bay Conservation and Development Commission

County of Solano

Solano County Mosquito Abatement District

U.S. Fish and Wildlife Service

U.S. Soil Conservation Service

U.S. Water and Power Resource Service

This document was prepared with financial assistance from the U.S. Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under the provisions of the Federal Coastal Zone Management Act of 1972, as amended, and from the San Francisco Bay Conservation and Development Commission under the provisions of the Suisun Marsh Preservation Act of 1977.

March, 1980

Attachment D

TABLE OF CONTENTS

Continued

Exhibit "G"

SUISUN RESOURCE CONSERVATION DISTRICT STANDARDS COVERING DIKING, FLOODING, DRAINING, FILLING AND DREDGING OF TIDAL WATERS, MANAGED WETLANDS AND TIDAL MARSH WITHIN THE PRIMARY MANAGEMENT AREA OF THE SUISUN MARSH AS PROVIDED FOR BY SECTION 2900 et seq, OF THE PUBLIC RESOURCES CODE

Section I - Title:

These standards shall be known as the Suisun Resource Conservation District (SRCD) Standards for diking, flooding, draining, filling and dredging of tidal waters, managed wetlands and tidal marshes within the Primary Management Area (PMA) of the Suisun Marsh (Marsh). These standards are established in accordance with the provisions of Section 29401(d) of the Public Resources Code (PRC).

Section II - Definition:

1) Tidal waters are defined as open water areas within the PMA which are subject to daily tidal action.
2) Managed wetlands are defined as leveed areas within the PMA in which water inflow and outflow is artificially controlled, or in which waterfowl food plants are cultivated, or both, to enhance habitat conditions for waterfowl and other water-associated birds and wildlife.
3) Tidal marshes are defined as vegetated areas within the PMA which are subject to daily tidal action.

Section III - Purpose:

The purposes of these Standards covering diking, flooding, draining, filling and dredging are to preserve, protect and enhance the plant and wildlife communities within the PMA. By doing so, they will serve to protect the public interest through the development of wildlife habitat and prevention of mosquitoes. The improvement of the present water management practices called for by Sections 29003(b) and 29401(d) of the Suisun Marsh Preservation Act and the policies of the Land Use and Marsh Management Section of the Suisun Marsh Protection Plan will require the improvement of the water management facilities and procedures within the PMA. The standards and requirements of this element of the SRCD's component of the Local Protection Program specify how such improvements shall take place. They also meet the objective of minimizing activities in tidal marshes and waters.

Section IV - Scope:

These standards shall apply to all private activities undertaken on privately owned land within the PMA and are intended to supplement the provisions of any Solano County Grading and Erosion Control Ordinance within the PMA.

Section V - General Principles and Standards:

Diking, flooding, draining, filling and dredging activities shall be conducted so as to minimize any adverse effects on desirable plant and wildlife communities and to minimize the

potential for erosion and sedimentation. The following basic principles and standards shall serve as the minimum guidelines for the protection of plant and wildlife communities and the control of erosion and sedimentation:

1) Stripping or burning of vegetation, or other soil disturbance shall be done in a manner which will minimize adverse impacts on desirable plant and wildlife communities and control erosion and sedimentation.

2) Existing native vegetation shall be retained, protected, and supplemented wherever practical. Development shall be accomplished so that existing trees will be preserved whenever practical.

3) Exposure of soil to erosion by removal of vegetation shall be limited to the smallest area practical and for the shortest time practical. Soil exposure shall not exceed an area in which work can be completed during a single construction season to insure that soil stability is estalished well in advance of the rainy season. In general, soil disturbance shall be limited to the period between April 1 and October 1.

4) Permanent control structures should be installed and final vegetation established as soon as practical.

5) Facilities shall be constructed in a manner which will minimize erosion and sediment deposition in adjacent waterways and wetlands.

6) Slopes, both cut and fill, shall not be steeper than 2:1 unless a thorough geological and engineering analysis indicates that steeper slopes are safe and appropriate erosion control measures are specified.

7) Cuts and fills shall not encroach upon existing watercourses, or constructed channels in a manner so as to adversely affect adjacent properties or the carrying capability of the watercourse.

8) Disposal of cleared vegetation and excavated materials shall be done in a manner which reduces the risk of erosion and sedimentation and shall conform to the provisions of these standards.

9) Diking, filling and dredging activities shall be conducted so as to minimize interference with critical wildlife activities such as nesting and breeding.

Section VI - Specific Principles and Standards:

A. TIDAL WATERS

1) Diking - before 1900 major areas of the PMA were leveed to isolate them from tidal action and to permit the managed application of tidal waters for agricultural purposes. Under the policies of the Suisun Marsh Protection Plan, residual areas of tidal waters will remain in their current state. To assure that this happens, no new levee shall be constructed which isolates a water area, or portion thereof, that is currently subject to daily tidal action except in

ATTACHMENT "A"

SUISUN MARSH LEVEE SPECIFICATIONS

SCOPE

This specification covers the design, construction and maintenance of levees in the PMA of the Suisun Marsh. Levees are embankments which protect managed wildlife habitat areas in the Suisun Marsh from uncontrolled flooding.

DEFINITIONS

1. Exterior Levees - embankments which prevent uncontrolled flooding of marshland due to tidal action. The crown of these levees is normally about 9 feet above zero tide with a 12 foot top width.
2. Interior Levees - embankments which allow for management of water inside exterior levees. They are not exposed to tidal action. The crown of these levees is normally less than 4 feet above the natural ground with a top width of 10 feet.
3. Core - locally available material which is placed in a trench dug along the longitudinal axis of the levee.

PURPOSE

1. Exterior Levees - the purpose of exterior levees is to facilitate water storage and control in order to promote wildlife habitat in the Marsh. Exterior levees are used to control tidal flow onto managed wetlands and prevent their uncontrolled flooding. They are used in conjunction

with interior levees, ditches, and water control structures to supply to or drain water from the land which they surround.

2. Interior Levees - the purpose of interior levees is to isolate specific areas within exterior levees for the purpose of providing those areas with individual control of water. They contain and control water used for ponding during the duck season and for leaching afterwards.
3. Cores - the purpose of installing a core is to eradicate existing animal channels in a levee and reduce water seepage through it.

CONDITIONS WHERE THESE STANDARDS APPLY

Levees are usually built from spoil excavated from the inboard side of the levee or dredged from channels. The levee standards defined in this section should be used only on sites where:

1) The normal maximum water depth against an exterior levee does not exceed 7 feet above zero tide.

2) The maximum water depth against an interior levee does not exceed 3 feet above the natural ground.

3) The damage which is likely to result from a levee failure is low.

4) The area to be protected is used for wildlife habitat or agriculture and has minimal structural improvements.

Where one or more of the above conditions is exceeded, special design levee standards are required.

DESIGN CRITERIA

A. Material - levee material shall be mineral or peat soils free of consolidated sod, roots, brush and other vegetative matter.

B. Placement - fill shall be placed so as to permit free drainage of surface water. The maximum fill height from the surface of the ground at start of construction for any one construction stage shall be five feet. If the designed height is greater than 5 feet, the levee shall be built in two lifts. Lumps and clods of earth shall be broken up by shaping or discing.

C. Cross Section -

1) New levees - the minimum standards for the construction of new levees shall be as follows:

a) Exterior levees:

i) The foundation shall be cleared and stripped of brush, trees, roots and other vegetation and debris. In soils containing excessive amounts of organic materials, a core trench shall be excavated to a minimum depth of 2 feet.

ii) The minimum top width shall be 12 feet.

iii) The minimum design water height (Hw in Figure 1) shall be 9 feet at zero tide.

iv) The minimum design side slope shall be 2:1 on both sides.

v) The minimum freeboard (Hf in Figure 1) shall be 2 feet; where wave action is expected, the freeboard shall be at least 3 feet.

vi) Existing tule berms on the outboard side of the levee shall be retained to the maximum extent practical.

vii) The minimum berm width between the inboard toe of the levee and the edge of any borrow ditch shall be 10 feet (See Figure 1). For levees having a design water depth of greater than 5 feet, a line drawn between the design water surface (Hw on Figure 1) and the toe of the levee shall not intersect the borrow ditch. In areas of organic soils, the minimum berm width shall be 25 feet.

viii) The minimum allowance for settlement (Hs in Figure 1) shall be 30% of the design height. If the levee must be in place and functional before natural settlement can take place, it shall be shaped or compacted by mechanical means. The levee shall be inspected to assure that the design cross section is obtained after settling.

ix) All new levees shall be constructed with a core.

x) Outboard faces shall be riprapped only in areas which are exposed to major wave action and are not protected by vegetative berms.

b) Interior levees:

i) The minimum top width shall be 10 feet.

ii) The maximum designed water height (HW in Figure 1) shall be 3 feet.

iii) The minimum design side slopes shall be 2:1 both sides.

iv) The minimum freeboard (Hf in Figure 1) shall be 1 foot. If the water depth is greater than 1 foot, the minimum freeboard shall be equal to the depth of the water.

v) The minimum allowance for settlement (Hs in Figure 1) shall be 30% of the design height. If a levee must be in place and functioning before natural settlement can take place, it must be shaped or compacted by mechanical means. The levee shall be inspected to assure that the design cross section is obtained after settling.

vi) All new levees shall be constructed with a core.

vii) No interior levees shall be riprapped.

2) Existing Levees - the minimum standards for the repair and maintenance of existing levees shall be as follows:

a) Exterior levees:

i) Exterior levee contours shall be restored to match the previously existing section. If the

previously existing cross section is not equal to or better than that described in (1), upgrading the levee to that standard should be considered.

ii) If the existing side slope is eroded beyond 1.5:1, the slope should be rebuilt to 2:1.

iii) Coring should be done only where required to repair damage from animal channels or eliminate seepage.

b) Interior levees:

i) Interior levee contours shall be restored to match the previously existing section. If the previously existing cross section is not equal to or better than that described in (1), upgrading the levee to that standard should be considered.

ii) If the existing side slope is eroded beyond 1.5:1, the slope should be rebuilt to 2:1.

iii) Coring should be done only where required to repair animal channel damage or eliminate seepage.

D. Repair of Leaking Levees and Restoration of Settled Levees -

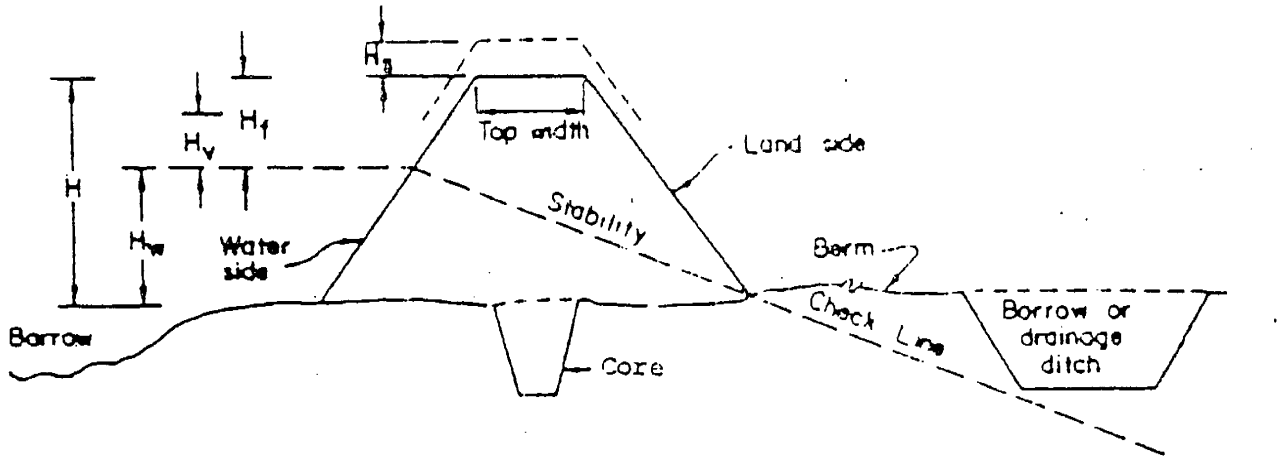
1) Levee disturbance shall be held to the minimum consistent with correcting the problems and special care shall be taken not to disturb levee footings.

2) Cores shall be a minimum of 2 feet deep, measured from the crown of the levee.

3) In areas where settling is known to be a problem, the height and width of the levee shall be minimized to reduce settling problems.

FIGURE I

SECTION THROUGH NEW LEVEES



The design height of the levee (H) will be the sum of the design high water storage (H_w), the added height (H_v) for wave action, if any, and the freeboard (H_f). The constructed height will include an allowance for settlement (H_s), which will depend on the foundation and material used in construction. The actual design high water stage should be based on the water surface profile.